METHOD FOR MAKING CARBON FABRIC AND PRODUCT THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for making carbon fabrics, more particularly, to such a method for making carbon fabrics having high conductivity with high magnetic wave shielding efficiency by carbonizing a woven fabric, which is made by using oxidized fibers of polypropylene as raw materials, and by keeping the shrinkage of the fabric controlled below 30%.

2. Description of the Related Art

Conventional carbon fabrics are commonly formed of carbon fiber bundles by weaving. Because carbon fibers are fragile, it is not practical to directly weave carbon fibers into fabrics. Further, carbon fabrics directly woven from carbon fibers have a loose structure with big gaps in carbon fiber bundles. Therefore, regular carbon fabrics are not suitable for use to shield magnetic waves directly.

However, oxidized fibers, which are the raw material for making carbon fibers, are soft fibers having extensibility over 10%. Through a special heat treatment, fabrics of oxidized fibers can be processed into carbon fabrics of high conductivity high conductivity with high magnetic wave shielding efficiency.

SUMMARY OF THE INVENTION

It is the primary objective of the present invention to provide a method for making a carbon fabric, which is practical for making a carbon fabric of high conductivity and high density suitable for making magnetic wave shielding materials.

It is another objective of the present invention to provide a method for making a carbon fabric, which is practical for making a variety of carbon fabric

products such as cloth, felt, and etc.

To achieve these objectives of the present invention, the method for making a carbon fabric comprises the steps of (a) preparing a raw fabric obtained from raw fibers by weaving, and (b) carbonizing said raw fabric into a carbon fabric; wherein the raw fibers for the raw fabric are oxidized fibers of polypropylene having a carbon content of 50 wt% at least, an oxygen content of 4 wt% at least, and a limiting oxygen index (LOI) of 35% at least.

Preferably, the carbon content of the raw fibers is over 55 wt%, the oxygen content of the raw fabrics is over 8 wt%, and the oxygen limiting index of the raw fibers is over 50%.

Further, a carbon fabric made according to the above-mentioned method has a density over 1.68 g/ml, and magnetic wave shielding efficiency over 30 dB subject to the magnetic wave having a frequency ranging from 300 MHz to 2.45 GHz.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing the steps of the method according to the present invention.

FIG. 2 is a picture obtained from a raw fabric through an electronic microscope according to the present invention.

FIG. 3 is a picture obtained from a carbon fabric through an electronic microscope according to the present invention (carbonization temperature at 1300°C).

FIG. 4 is a picture obtained from a carbon fabric through an electronic microscope according to the present invention (carbonization temperature at 2500°C).

FIG. 5 is a picture obtained from a conventional carbon fabric through an electronic microscope.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, the method for making a carbon fabric of the present invention is a continuous, integrated flow. At first, a raw fabric **F11** is obtained from oxidized fibers of polypropylene through a weaving process, and rolled up into a material roll **F1**. The raw fabric **F11** is then delivered in proper order through an anterior-roller set **1** and a tension wheel set **2** to a high-temperature oven **4** to receive a carbonization treatment. The treating temperature during the carbonization treatment can be maintained constant, or continuously changed, or interruptedly changed. Further, in order to prevent pyrolysis or ashing of fibers of the raw fabric **F11** during the carbonization treatment, an inert gas **3** is filled in the high temperature oven **4** for protection. After the carbonization treatment, the raw fabric **F11** has been changed to be a carbon fabric **F21**, which is then delivered through a posterior roller set **5**, and then rolled up to form a roll of finished product **F2**.

The temperature of the carbonization treatment is within 700-2500°C, and the duration of the carbonization treatment is about within 2-240 minutes. The high temperature oven **4** has two open ends, i.e., one is the air inlet and the other is the air outlet for the entrance and exit of the inert gas **3**.

The main manufacturing equipment is as described above. However, several high temperature ovens may be connected in series to run the carbonization treatment. The number and arrangement of high temperature ovens may be adjusted subject to different requirements. The temperature control during the carbonization treatment is achieved by means of a set of controllers and heating systems.

A carbon fabric made according to the aforesaid method has the density greater than 1.68 g/ml, carbon content over 70 wt%, sheet resistance below 100 Ω/cm^2,

single fifer electrical resistivity 5.56×10^{-3} Ω-cm, magnetic wave shielding efficiency 30dB at 300MHz-3GHz (i.e., magnetic wave shielding effect over 99.9 %; relationship between dB value and magnetic wave shielding efficiency is outlined in following table I).

Table I: relationship between dB value and magnetic wave shielding efficiency.

dB value	Shielding Efficiency (%)
0~10	90
10~30	90-99.9
30~60	99.9-99.9999
60~90	99.9999-99.9999999
90~120	Over 99.9999999

EXAMPLE I to IV

Plain fabrics of oxidized fibers of polypropylene were used as raw fabrics, which had count 2/11.3 Nm, fabric density 27×24 (per inch), density 1.38 g/ml, carbon content 57 wt%, oxygen content 12 wt%, LOI (limiting oxygen index) 55%. FIG. 2 shows the structure of the raw fabrics when viewed through a microscope.

The prepared raw fabrics were then processed through the carbonization process lot by lot. The duration of the carbonization treatment is 10 minutes. The carbonization temperatures for Examples I to IV were 900°C, 1000°C, 1300°C, and 1500°C respectively. During carbonization, helium was supplied and used as a protective gas, and at the same time the anterior-roller set **1** and the posterior roller set **5** were rotated at different speeds to control the shrinkage of the raw fabrics below 30 %, and the tension wheel set **2** was controlled to stabilize the tension of the raw fabrics. FIG. 3 shows the microscopic structure of Example III.

EXAMPLE V:

The carbon fabric obtained from the aforesaid Example II was used and sent to a high temperature oven where temperature was increased at 5°C/min to 2500°C and then maintained at 2500°C for 2 minutes.

COMPARISON SAMPLES I & II:

Use same materials as the aforesaid Examples I to IV, and then carbonize the materials at 800°C and 700°C respectively while the other conditions maintained unchanged. The microscopic structure of Comparison Sample II is as shown in FIG. 4.

COMPARISON SAMPLE III:

Comparison Sample III was a plain woven carbon fabric manufactured by Toray Industries, Inc., which is made by carbon fibers having six thousands long fibers per bundle. The microscopic structure of this material is shown in FIG. 5 (ratio of magnification: 25). Gaps among fibers are apparent.

Characteristics and magnetic wave shielding efficiency of Examples I to V and Comparison Samples 1 to 3 are as follows:

Table II: characteristics of carbon fabrics

	Carbonization temperature (°C)	Carbon content (wt%)	Density (g/ml)	Sheet resistance (Ω-cm^2)
Example I	900	80.0	1.81	18.5
Example II	1000	85.4	1.83	41.7
Example III	1300	97.8	1.75	34.8
Example IV	1500	97.9	1.76	33.5
Example V	2500	98.3	1.90	22.8
Comparison Sample 1	800	74.0	1.77	1198.4
Comparison Sample 2	700	70.7	1.69	**
Comparison Sample 3	Unknown	95.0	1.74	**

	Electrical resistivity (Ω-cm)	Warp density (bundle/inch)	Weft density (bundle/inch)
Example I	5.6×10^{-3}	31.0	29.8

Example II	6.9×10^{-3}	30.4	27.6
Example III	1.5×10^{-3}	30.2	27.6
Example IV	1.3×10^{-3}	31.5	28.4
Example V	6.9×10^{-4}	32.4	30.4
Comparison Sample 1	1.05	30.0	28.4
Comparison Sample 2	**	28.4	28.2
Comparison Sample 3	$4.3\text{x}10^{-3}$	12	12

Remark 1: Electrical resistivity was measured on single fiber.

Remark 2: Comparison Sample 2 was an insulator.

Remark 3: Sheet resistance of Comparison Sample 3 not measurable.

Table III: Magnetic wave shielding efficiency of carbon fabrics at different carbonization temperatures

	Magnetic wave shielding efficiency at different frequencies (dB)			
	300 MHz	900 MHz	1.8 GHz	2.45 GHz
Example I	34.07	35.04	36.19	37.04
Example II	32.23	30.79	33.38	33.02
Example III	46.34	43.98	49.12	48.32
Example IV	42.59	48.57	49.96	47.78
Example V	48.50	46.82	50.43	51.07
Comparison Sample 1	14.46	13.02	5.79	15.56
Comparison Sample 2	0.83	0.96	1.32	0.88
Comparison Sample 3	0.50	0.11	0.76	0.11

As indicated in the aforesaid tables, conventional carbon fabrics have big gaps in fiber bundles as shown in FIG. 5, resulting in low magnetic wave shielding efficiency (see Comparison Sample 3 in Table III). A carbon fabric made according to the present invention has a structure of high density. The arrangement of fibers of the carbon fabric according to the present invention can be anisotropic, as shown in FIGS. 3 and 4. Therefore, the invention eliminates the problem of big gaps in fiber bundles. A

carbon fabric made according to the present invention has a satisfactory magnetic wave shielding efficiency, and can be used for making heating material.

According to the aforesaid Examples I to V, the magnetic wave shielding efficiency is over 30dB when at 300MHz to 2.45GHz. Preferably, the carbonization temperature is within about 900°C-2500°C, and the time of carbonization is at about 10-100 minutes.

Further, the higher the density, carbon content, oxygen content, or limiting oxygen index of the fibers used is, the higher the carbon content and density of the carbonized carbon fabric will be. In consequence, a relatively better magnetic wave shielding efficiency can be achieved.